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Inflation Targeting and Quantitative Tightening: Effects of Reserve Requirements in Peru

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Abstract[1]

This paper provides an overview of the reserve requirement measures undertaken by the Central Bank of Peru. It provides a rationale for the use of these instruments as well as empirical evidence of their effectiveness. In general, the results show that tightening reserve requirements has the desired effects on interest rates and credit levels at both banks and smaller financial institutions (*cajas municipales*).

JEL classifications: E51, E52, E58 G21
Keywords: Nonconventional monetary policy, Inflation targeting, Reserve requirements.

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1. Introduction

As a policy response to address the macroeconomic challenges brought about by financial dollarization and the vulnerabilities it implied for the financial system, the Central Bank of Peru (BCRP) adopted an inflation targeting (IT) regime in 2002, becoming the first policy authority to implement this framework under a dual monetary system.

The IT regime in Peru has a particular design. The BCRP actively intervenes in the foreign exchange (forex) market to smooth exchange rate fluctuations and to build international reserves as a self-insurance mechanism against negative external shocks. Moreover, reserve requirement (RR) policy is used as an active monetary control tool to tame the impact of capital flows on domestic credit conditions denominated in both domestic and foreign currency. The BCRP has also set high RRs on foreign currency liabilities as a prudential tool to face liquidity and foreign-currency credit risk. These additional policy tools have relaxed the tradeoffs that the BCRP faces when implementing standard monetary policy within an IT regime that simultaneously takes into account financial stability considerations.

The ready use of RRs in the Peruvian monetary policy framework has allowed the BCRP to induce the necessary quantitative tightening (QT) required to face the domestic spillover effects of the unprecedented quantitative easing (QE) policies engaged in developed countries.

Based on this experience, this paper evaluates the relevance of RR as a complementary instrument for monetary policy. To this end, we provide a detailed account of the rationality of its use in Peru, the way RR policy changes propagate and affect credit conditions, and a quantitative assessment of its impact on monetary and credit conditions using a counterfactual policy evaluation analysis.

The paper is organized as follows: Section 2 provides an overview of the Peruvian monetary framework, including standard interest rate setting. Section 3 discusses the use of RR as a monetary policy tool, the transmission mechanism of RR changes, and the control of financial dollarization risks and liquidity risks. Section 4 performs an empirical evaluation of RR policies, and Section 5 concludes.

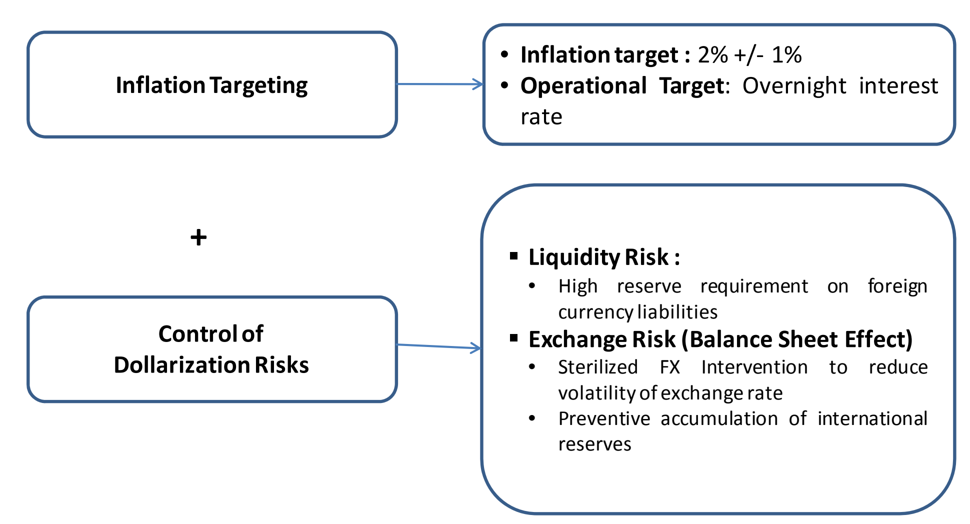
2. The Monetary Policy Framework

2.1 Overview

The current monetary policy framework in Peru has been in place since 2002. It is best characterized as a full-fledged IT regime that takes explicit account of the risks brought about by financial dollarization (FD). The target is a 2 percent annual increase in the consumer price index with a tolerance band that ranges from 1 to 3 percent. Before IT adoption, monetary policy in Peru was implemented by a monetary target framework that used the annual money base growth rate as intermediate target[2] and at the same time included instruments such as forex intervention and high reserve requirements for foreign currency deposits.[3]

At the time the BCRP adopted IT, the aforementioned policy tools used to confront FD risks were still in place. Webb and Armas (2003)[4] and Armas and Grippa (2005) judged the implementation of the IT framework in a financially vulnerable economy as a combination of a standard interest rate rule setting plus the active use of other instruments to control financial risks. Figure 1, taken from Armas and Grippa (2005), illustrates the IT framework set up in Peru.

Figure 1. Inflation Targeting plus Dollarization Risk Control Framework in Peru



[2] Armas et al. (2001) describe the evolution of the monetary policy framework in the1990s and how the Central Bank of Peru was creating the pre-conditions to adopt an IT scheme.

[3] The bulk of foreign currency deposits are denominated in U.S. dollars, and around 40 percent of total deposits are denominated in foreign currency.

[4] Webb and Armas (2003) provided the first account of the implementation of IT in a dollarized environment. In this environment, Moron and Winkelried (2005) studied the optimal interest rate rule that a central bank should use considering a framework where a Céspedes et al. (2004) type of balance sheet effect operates. Armas and Grippa (2005) describe the rationale for smoothing exchange rate volatility via sterilized forex interventions, reserve requirements on foreign currency liabilities of commercial banks, and the accumulation of central bank foreign currency reserves.

Since 2008, RRs have been changed frequently to complement policy rate changes. The main reason for this new role for RRs was the launching of the unprecedented expansionary monetary policies in developed economies, which triggered the zero-lower bound for their policy interest rates and the implementation of QE. Emerging-economy central banks had to respond with different actions to deal with the spillover effects of these ultra-easy policies, manifested in capital inflows and low levels of international interest rates. Figure 2 summarizes the different economic cycles and policy responses of both developed and emerging economies during the QE period.

Starting in 2008, changes in the marginal and the average RR rates have been used cyclically in tune with the new international environment. RRs have been raised in response to capital inflow episodes, such as those observed in 2008Q1 and more recently since 2010S2, following the announcement QE2. This RR tightening was aimed at limiting the impact of capital inflows on credit, particularly those denominated in foreign currency. This also resulted in the BCRP's increased capacity to inject foreign currency liquidity in case of a sudden capital flight.

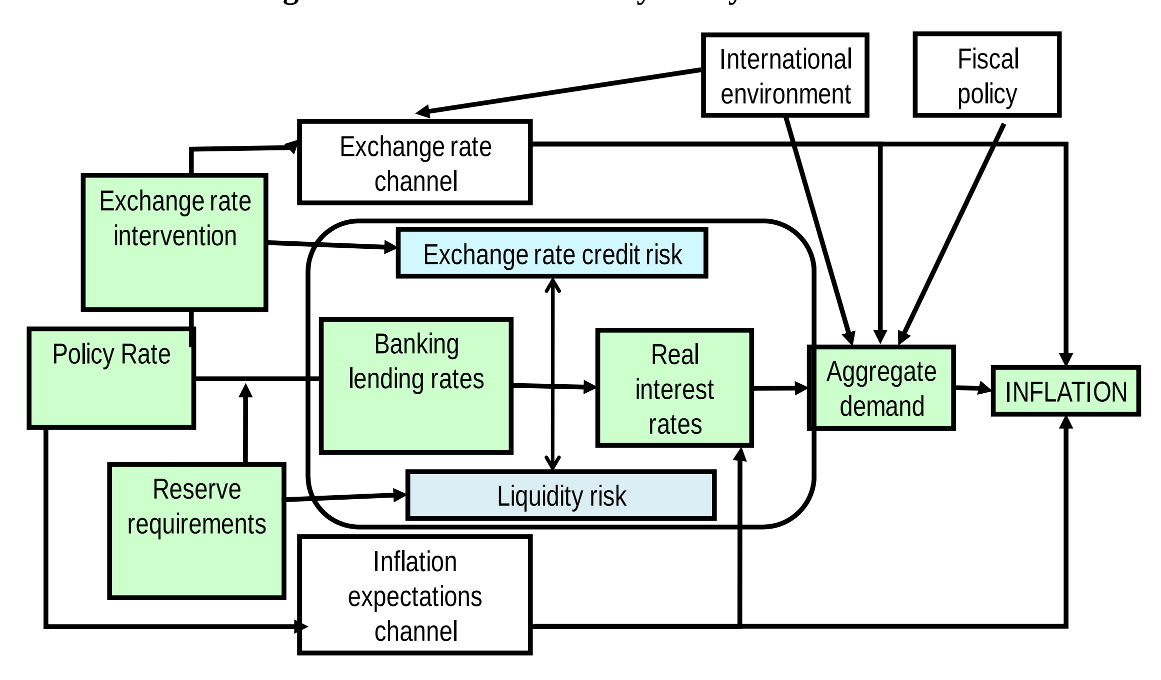
Figure 2. Quantitative Easing and Quantitative Tightening

Developed Countries	Emerging Economies
Low/Negative Growth	High Growth
Zero Lower Bound	Neutral Stance
Expansion of CB assets buying local bonds	Expansion of CB assets accumulating international reserves
Monetary base expansion (repos, QE)	Monetary base expansion (reserve requirements, sterilization: QT)
CB offering repos to help illiquid banks	CB making sterilized operations to absorb liquidity from banks
House Prices Falling	House Prices Rising
Currency Depreciation	Currency Appreciation

This policy framework has proven to be effective in dampening financial risks, in spite of the high degree of FD. In contrast to what happened during the Russian crisis, when a sudden stop in capital flows triggered a credit crunch,[5] during the 2008 sudden-stop episode, the BCRP was better prepared: high international reserves and higher RRs allowed a massive injection of liquidity into the system and prevented another credit crunch.[6]

Figure 3 illustrates how the use of nonconventional monetary policy tools complements the use of the short-term interest rate. Exchange rate market interventions aimed at dampening excess exchange rate volatility limit the probability of systemic risk associated with sharp exchange rate depreciations, whereas the use of high and cyclical RRs in foreign currency contributes to curbing systemic liquidity risks associated with FD.

Figure 3. Peruvian Monetary Policy Framework



2.2 Standard Interest Rate Setting under the Peruvian IT (2002-2012)

The operational target of monetary policy is the short-term interest rate. This operational target is used by the BCRP, as it is by any other IT central bank, to deliver its monetary policy stance to the market. During periods of high inflation or output gap levels, the central bank tends to

[5] Castillo and Barco (2009) evaluate the policy responses of Peru during this episode.

[6] See León and Quispe (2010) and Castillo and Barco (2009) for a detailed account of the Central Bank response to the global financial crisis.

increase its policy interest rate to fight inflationary pressures; conversely, when inflation is below the central bank target and the output gap is negative, the central bank tends to cut its policy rate.

However, in the case of a financially dollarized economy, interest rate setting also has to take into account how FD affects the transmission mechanism of monetary policy. The BCRP addresses this issue by using an inflation forecasting model (MPT) that explicitly takes into account the impact of dollarization on credit market conditions and on the dynamics of the exchange rate and inflation (Winkelried, 2013). In this model, dollarization reduces the impact of monetary policy on inflation and the output gap, since a large depreciation not only generates a typical positive impact on exports but also triggers a negative impact on the financial position of firms that have currency mismatches. Thus, with FD, the typical expansionary effect of the exchange rate channel of monetary policy after a policy easing is muted. Additionally, the MPT takes into account the impact of both RR changes and exchange rate market interventions on the dynamics of interest rates and the exchange rate.

Figure 4 shows the evolution of the policy rate, the output gap, and core inflation since 2004. As shown, the policy rate has actively responded to the evolution of both inflation and the output gap. This has been particularly true during episodes of important changes in indicators such as core inflation and inflation expectations.

Figure 4. The Pace of the Monetary Policy Interest Rate

Note: All variables are demeaned.

Estimates of the policy rule for the period 2002-2009 show that this rule not only satisfies the Taylor principle; it also indicates that the central bank gives greater weight to reducing inflation volatility than output gap volatility. The estimations reported by Salas (2011) show that the interest response to inflation is close to 1.9 and the response to output is close to 0.5.[7] To the extent that changes in RRs affect money and credit conditions, the setting of the short-term interest rate also takes into account the level of RRs and the estimated impact of foreign exchange market interventions.[8]

Two episodes clearly highlight the active response of the BCRP to changes in expected inflation and the output gap. The first one began in July 2007, when the central bank started to raise interest rates in response to a persistent rise in inflation. During that period, the BCRP increased its reference interest rate eight times, a total increase of 200 basis points, from 4.5 to 6.5 percent. The second period followed the Lehman Brothers collapse. The BCRP aggressively cut the policy interest rate from 6.5 to 1.25 percent in six months. The interest rates cuts were effective not only in reducing interest rates in the money market, but also in decreasing interest rates in the rest of the financial system. For example, the average interest rate on loans up to 360 days fell from 15.5 to 11.1 percent from January to December 2009.

3. The Use of RR by the BCRP

The BCRP uses RRs mainly for: a) monetary control, b) limiting dollarization risks, and c) increasing the maturity of the bank's external leverage.

3.1 RRs as an Active Monetary Control Tool

Before the international crises, there was no major role for RRs as a monetary tool in mainstream monetary policy and theory. Bindseil (2003) summarizes in his chapter on RR:

> Complex systems with an impressive number of differently treated reserve base categories were created and in some years reserve ratios were changed at a high frequency. Today, these functions of reserve requirements are no longer taken for granted, like most other doctrines of the monetary control era. Instead, there is

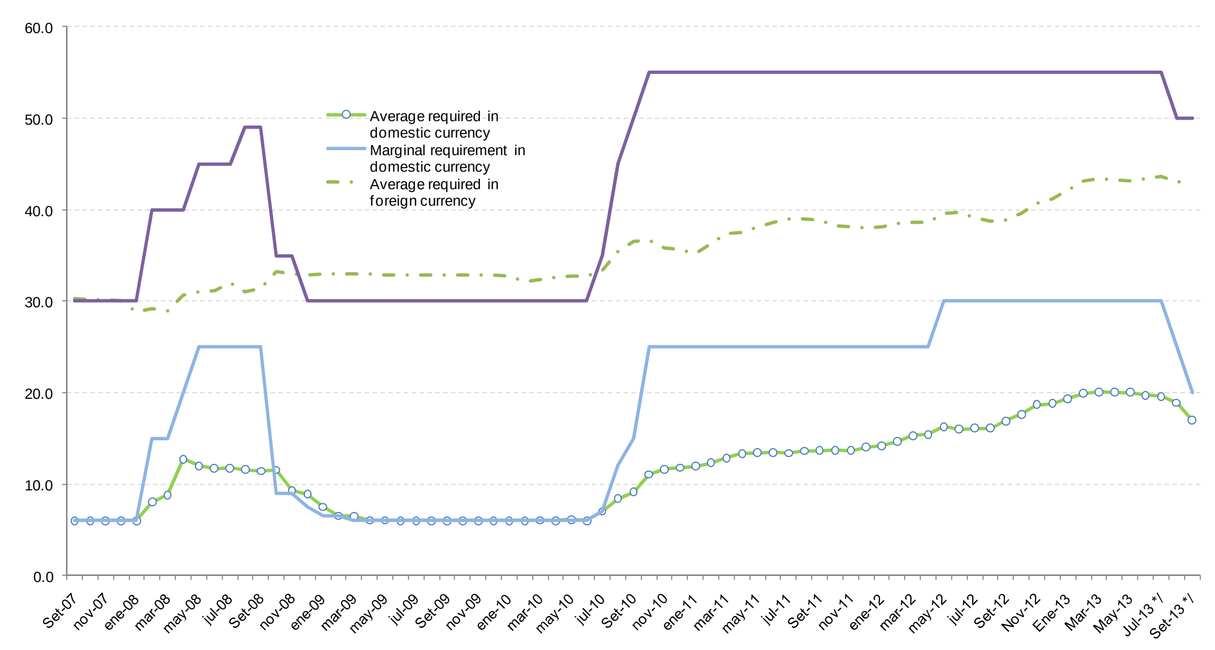
[7] These values correspond to the mode of the posterior distribution of the parameters. The corresponding confidence intervals located these parameters between 1.23 and 2.4 for the case of the interest rate response to core inflation and between 0.3 and 0.6 for the case of the output gap.
[8] Salas (2011) explains how the semi-structural quarterly model (MPT) incorporates forex intervention.

consensus that the main purpose of reserve requirement is the stabilization of short-term interest rates (p. 202).

Nonconventional instruments such as RRs have been used in Peru since the 1990s to preserve the transmission channels of monetary policy and prevent systemic risks associated mainly with exchange rate mismatches and liquidity risks created by FD.

The scope and use of RRs have changed in recent years. Before IT adoption and in response to high FD, RRs for foreign currency obligations were higher than those for domestic currency obligations. Differential rates seek to encourage banks to internalize the risk of granting dollar-denominated loans to economic agents that do not generate dollar income and to create a foreign exchange liquidity buffer to reduce systemic liquidity risks, given that the BCRP cannot act as a lender of last resort (LOLR) in foreign currency. During this period, RRs were not used cyclically and only targeted domestic sources of bank funding.

Figure 5. Reserve Requirements in Domestic and Foreign Currency
(as a percent of total liabilities subject to reserve requirements)



In recent years, RRs have been used by the BCRP as a complementary tool to its short-term interest rate. As such, it has helped to break the tradeoff between macro and financial stability. In particular, the RR-induced QT dampened the expansionary effects of capital inflows

on domestic credit conditions and, through this channel, also reduced output gap and inflationary pressures. In the presence of RR policy, this QT effect on the output gap implies that the policy rate may not need to rise as much.[9] Therefore, the use of QT under persistent capital inflows is analogous to a fiscal policy tightening that also allows a lower monetary policy rate and a less appreciated domestic currency, and as such, it introduces a new dimension into the policy mix, one that also has to take into account the relationship between RR and policy rates.

Additionally, under massive capital inflows or very low international interest rates, FD strengthens the spillover from expansionary international monetary conditions to the domestic financial system, which weakens domestic monetary policy. This is so because the demand for credit switches towards foreign currency credit. Under these conditions, higher RR on dollar liabilities contributes to tempering this spillover effect of international financial conditions on domestic markets and therefore strengthens the transmission of domestic interest rate policy.

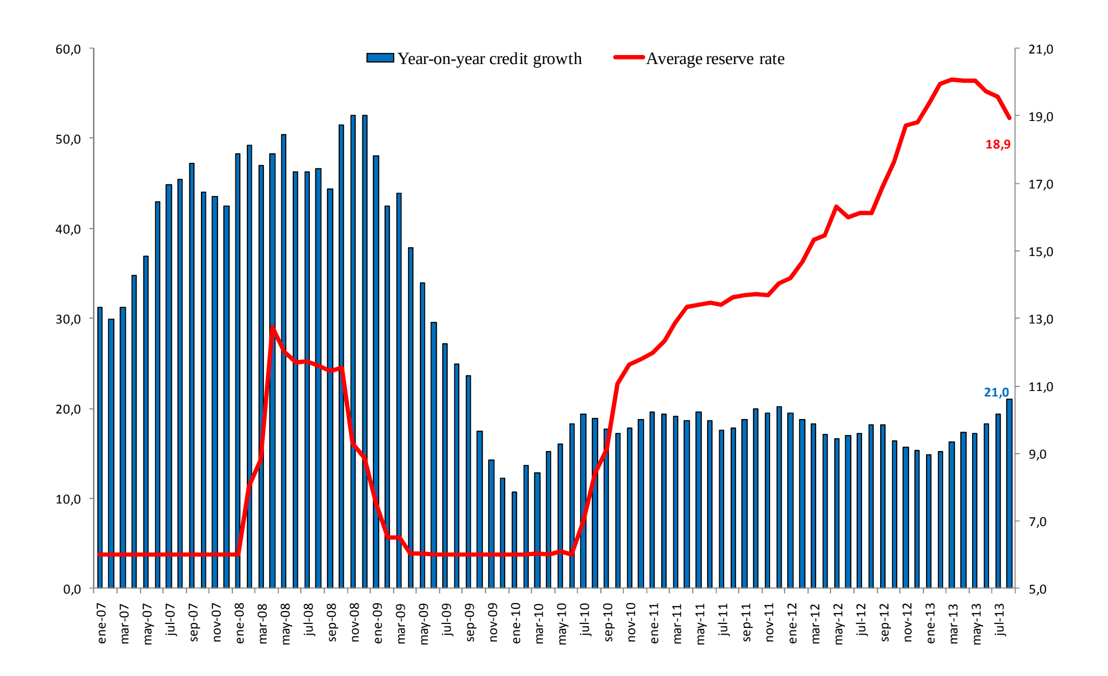
The use of RRs also contributes to monetary policy effectiveness. In those credit-market segments where the risk premium is high, lending interest rates are less sensitive to the policy rate, whereas changes in RRs, which operate through changes in financial intermediation margins, have a bigger impact on lending rates.

Countercyclical RRs can help to offset credit expansion by reducing the amount of the bank's loanable funds as a proportion of total bank assets. Massive capital inflows until April 2013 due to hitting the zero lower bound in the industrialized world (QE, Operation Twist, massive injection of liquidity by the ECB at a rate of 1 percent, etc.) brought about new macroeconomic and financial stability challenges. This time, the pre-emptive use of nonconventional tools by the BCRP helped to bring about a smoother credit cycle compared to the 2007-2008 episode (see Figures 6 and 7). The use of nonconventional policy instruments such as RRs and forex market interventions not only helped mitigate the foreign currency-induced credit risk and liquidity risk that FD creates but also contributed to breaking the tradeoff between reducing domestic demand pressures and attracting capital flows. The tradeoff occurs when the policy rate is increased to face domestic demand pressures amid episodes of strong capital flows.

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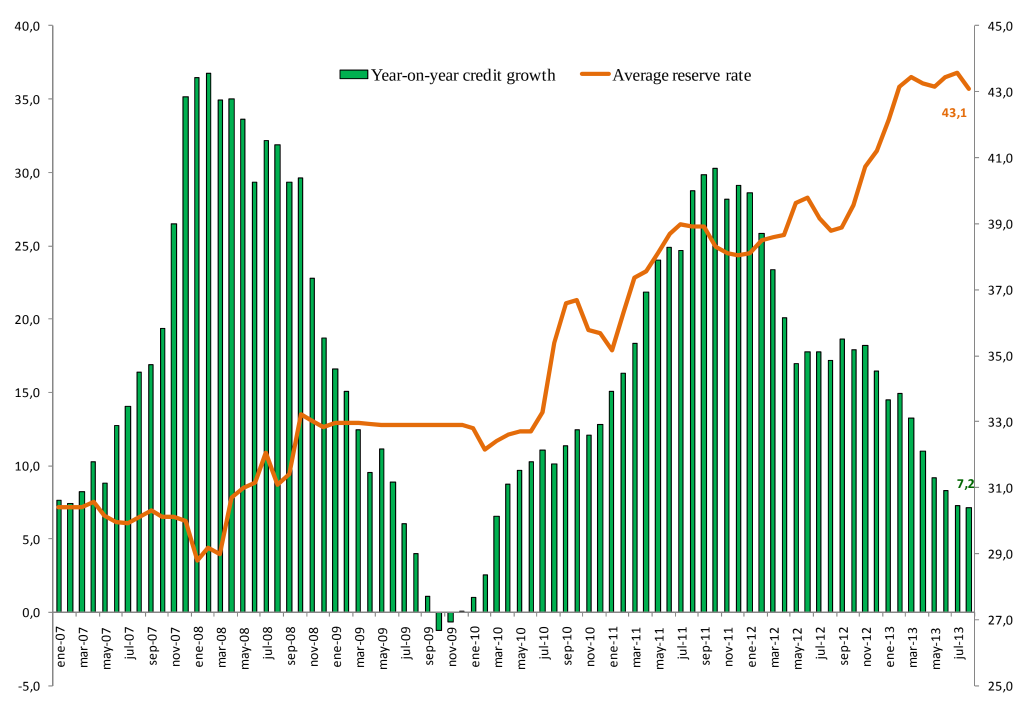
[9] As Vargas and Cardozo (2012) note, the combination of interest rate and RR policy can be thought of as part of an optimal policy framework. Also, in a DSGE model setup, Glocker and Towbin (2012) show that when RRs can achieve financial stability and let the interest rate deal with the inflation and output gap mix.

Figure 6. Banking System Domestic Currency Credit to the Private Sector and Average Reserves



Note: Left axis measures credit growth. Right axis measures reserve rate.

Figure 7. Banking System Foreign Currency Credit to the Private Sector and Average Reserves



Note: Left axis measures credit growth. Right axis measures reserve rate.

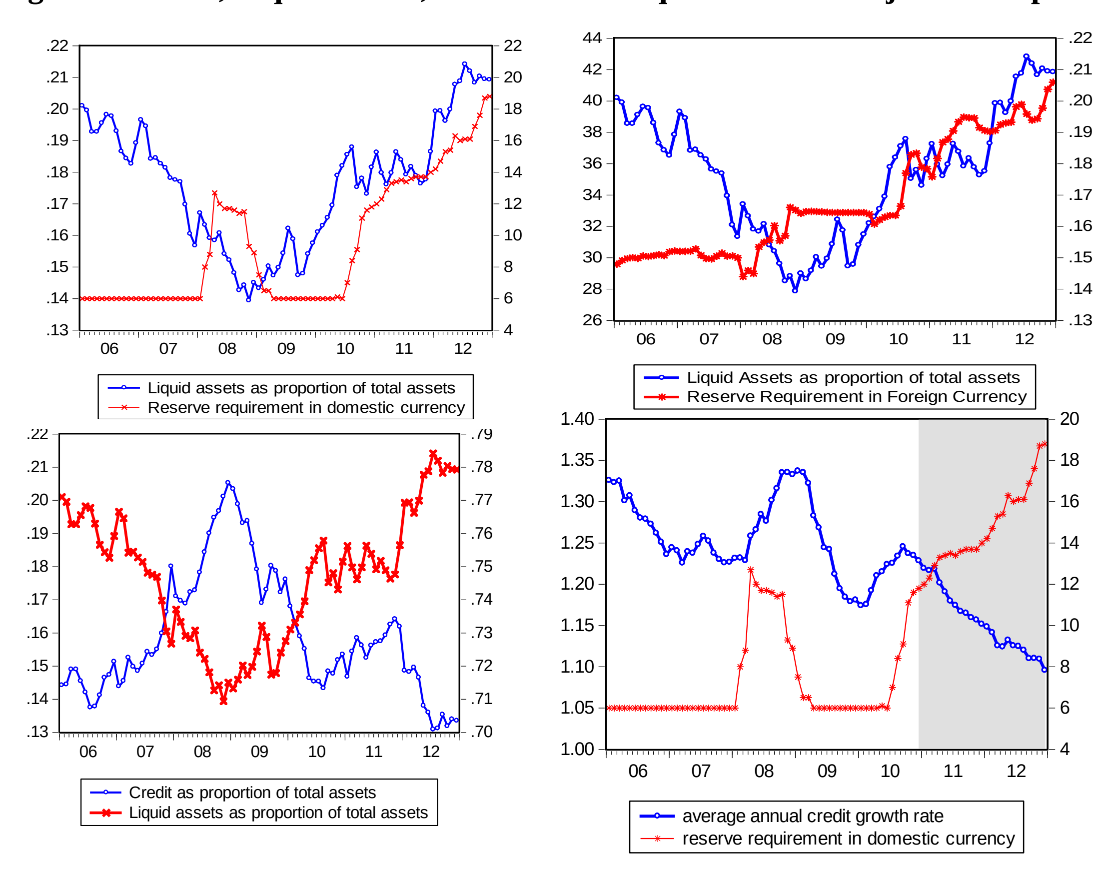
An increase in the RR rate implies that banks have to raise liquid assets to meet the new policy requirement. This tends to reduce the growth rate of credit, particularly when banks cannot substitute liabilities subject to RR for other sources of funding, like long-term foreign liabilities.[10] This is more likely the case for small-size financial institutions with limited access to the international financial markets, like Cajas Municipales and Cajas Rurales.

Thus, by increasing RRs during episodes of capital inflows and credit expansions, the BCRP seeks to reduce the probability of liquidity stress scenarios in the financial system. Higher RRs induce private banks to increase the availability of liquid assets, which also reduces their capacity to expand credit, particularly in foreign currency. Hence, RRs generate buffer stocks of liquidity both in domestic and foreign currency.

As Figure 8 shows, for Cajas Municipales, the increase in RRs between December 2009 and December 2012 was coupled by an increase in liquid assets and by a reduction in both the ratio of credit to total assets and credit growth. During this period, the BCRP not only increased marginal RRs but also raised average RRs. The marginal rate for domestic currency deposits was raised from 6 to 25 percent, while the marginal rate for foreign currency deposits was increased from 30 to 55 percent. Average RR rates for domestic currency deposits were raised seven times, totaling a 3.25 percentage point increase. As a consequence, the credit growth rate in Cajas Municipales fell from 22 percent to 9 percent during this period. This episode illustrates the main mechanism whereby RR policy impinges on credit. The RR rate for foreign currency deposits was increased ten times (total increase by 3.75 percentage points).

[10] In Peru, long-term foreign liabilities are not subject to reserve requirements up to a limit of 2.2 times the bank's net worth.

Figure 8. Credit, Liquid Assets, and Reserve Requirements at Cajas Municipales



Note: Information corresponds to the simple average of the 13 cajas municipals for each variable. Credit and liquid assets were obtained from the balance sheets statements published by the Superintendency of Banks.

The quantitative effect of this mechanism depends on both the duration and the intensity of increases in RRs and the way this policy is implemented. Figure 8 also shows a different behavior of credit and liquid assets during 2007 and 2008, when credit growth accelerated and liquid assets decreased in spite of the increase in RRs. During this period, the increase in RRs was much milder and short-lived than the rises observed since 2010. The effectiveness of RRs was rather reduced during this episode.[11] Also during this period, the increase in RRs was implemented only through increases in marginal rates and not through increases in the average RR rate. This distinction is important because an increase in the average RR has a stronger impact on bank credit supply than an increase on the marginal rate because the former is not contingent on the growth of bank deposits, as is the case for marginal RRs. Tovar et al. (2011) provide empirical evidence of the effectiveness of average over marginal RRs.

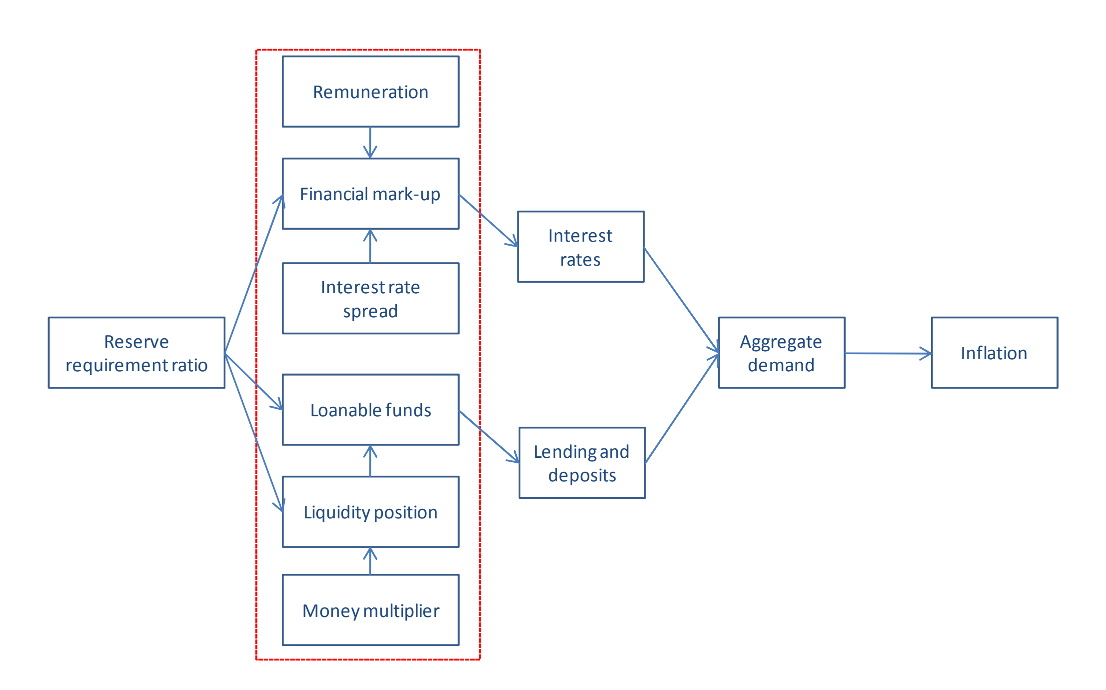
[11] See also Céspedes et al. (2012) for an account of this specific episode.

This implies that when the BCRP increases average RRs, banks have to increase their levels of liquid assets even when deposits are not increasing.

3.2 The Transmission Mechanism of Changes in Reserve Requirements

Reserve requirements affect money and credit conditions through a number of channels. Here a simple mechanism is described.[12] As Figure 9 shows, RRs first aim at reducing financial entities' primary loanable funds. Lower loanable funds imply lower liquidity and credit, which in turn has an impact on aggregate expenditure and inflation. This mechanism is more effective when the balance of liquid assets held by financial entities is low.

Figure 9. The Transmission Mechanism of Changes in Reserve Requirement Ratios



Second, higher RRs reduce banks' financial margins. Banks will seek to preserve them by widening the spread between lending and deposit rates (León and Quispe, 2010; Montoro and Moreno, 2011). They can achieve this by raising lending rates, reducing deposit rates, or both (Reinhart and Reinhart, 1999; Terrier et al., 2011). Higher market interest rates induce economic agents to reduce their expenditure, thereby attenuating inflationary pressures.

[12] More structural models are laid out in Glocker and Towbin (2012) and Carrera and Vega (2012). These two papers study RRs in the presence of financial frictions and how these requirements interact with standard monetary policy management.

Regarding empirical evidence, there is virtually no reference to Peru before 2008, given that RRs were not an active monetary policy tool. The initial approach when the BCRP started to use RR actively was to calibrate the impact of RRs through an accounting procedure that operated through banks' financial margins (León and Quispe, 2010). In particular, the prior was that the demand for credit was relatively inelastic to changes in the interest rate, mainly for small and medium-size firms. Additionally, it was clear that the effectiveness of the RR tool would depend on the degree of liquid substitute assets or external funding from foreign financial institutions. Data on the 2008-2012 events showed that this prior was not far from actual figures. The MPT assumes that changes in this instrument increase bank lending rates. The estimated impact of a 1 percent rise in the average RR rate is about 0.3 percent on average lending rates denominated in domestic currency and 0.1 percent on lending rates denominated in foreign currency. The low pass-through from RRs to foreign currency lending rates is explained by the larger set of alternative sources of funding available to corporate firms in foreign currency.

In practice, the implementation of monetary policy within a dual currency economy requires not only forecasting inflation conditional on the policy rate instrument but also needs continuous assessments of risks and vulnerabilities that FD poses under the baseline scenario. Nonconventional policy instruments are then set to curb those risks. For instance, if the baseline scenario assumes a period of capital inflows and persistent low international interest rates, then two risks arise: i) the risk of a rapid expansion of dollar loans and ii) a more intense local bank use of short-term liabilities with foreign banks. In this case, a rise in RRs on foreign currency liabilities is also considered a policy option in the baseline scenario.

3.3 Controlling Dollarization Risks with RR

The discussion on the importance of nonconventional policies as tools to prevent systemic risks and preserve financial stability has become more intense as a result of the international financial crisis. In developed economies, financial asset prices, such as stocks and bonds, are an element in the policy transmission mechanism. In contrast, emerging economies' shallow capital markets limit the role of financial asset prices in the monetary policy transmission. In this group of economies, the most important asset price is the exchange rate. This is particularly the case in financially dollarized economies such as that of Peru.

FD generates systemic risk at least on two crucial dimensions: first, by reducing the capacity of the central bank to act as a lender of last resort, FD increases the likelihood of liquidity shortage in the financial system; and second, since banks lend in foreign currency to non-tradable firms, FD also creates currency mismatches, which amplify foreign currency-induced credit risk. A common feature of these two additional sources of financial vulnerability implied by FD is that both generate negative externalities that justify policy intervention. They can also trigger potential non-linear dynamics with undesirable consequences for financial stability, which support the existence of precautionary policy actions.

RR policy is such one key preventive action. One way to rationalize RR policy is to consider it as a financial intermediation tax. This line of reasoning dates back as far as Keynes (1930) who described RR as a tax-type tool and sympathized with it:

> The custom of requiring bank to hold larger reserves that they strictly require for all money and for clearing purposes is a means of making them contribute to the expenses which the central bank incurs for the maintenance of the currency…For we ought to be able to assume that the central bank will be at least as intelligence as a member bank and more to be relied on to act in the general interest. I conclude therefore, that the American system of regulating by law the amount of the member bank reserves is preferable to the English system of depending on an ill-defined and somewhat precarious convention (p. 70).

Similar to the optimal taxation approach, the appropriate design and calibration of RR needs the identification of the externalities and distortions produced by financial intermediation and how these externalities and distortions can be reduced with the use of this policy instrument.

3.4 Liquidity Risk and Lender of Last Resort in Foreign Currency

The key externality at play with FD is a non-pecuniary one (but common before the creation of central banks on the continent). When banks intermediate in foreign currency, they do not take into account the fact that they are operating under a system without a LOLR in that currency. Banks assume that when they need foreign currency liquidity, they will be able to obtain it from the interbank market (local or international) at the market interest rate (related of course with the policy rate of the central bank that issues the foreign currency). However, this may not be case, particularly if all banks experience the same type of liquidity shortage.

This was the case in Peru during the 1998 Russian crisis. This shock triggered a sudden stop of capital flows and quickly damaged banks' foreign currency positions, particularly of those banks that heavily borrowed short-term from the international financial system. During this episode, banks were not able to obtain foreign currency liquidity even at very high levels of short-term interest rates. As a consequence, several banks had to suddenly curtail credit. The average local interbank rate in dollars was 8 percent in July 1998 (240 basis points against the one-month Libor rate) and soared to 12.9 percent in October (760 basis points against the one-month Libor rate).

A further rationale for the need for high RRs on foreign currency deposits is outlined in Castillo and Barco (2009). The paper provides an account of how contingent monetary policy that put special emphasis on providing international liquidity to the financial system during the period of financial distress was fundamental in diminishing the impact of the sudden stop during the financial crisis of the end of the 1990s.

Thus, under FD, preventive policy is required because private banks hold too little foreign currency liquidity. Higher RRs on foreign currency liabilities, together with the accumulation of international foreign reserves, contribute to reducing the adverse impact of this externality.

A historical reference of a financial system operating without a LOLR (like the FD case) was the nineteenth century and the beginning of the twentieth century, when bank run episodes were frequent across the world. In the United States, banks were required to keep a 25 percent reserve against deposits (National Bank Act of 1863). However, the role of RRs has decreased over time since the creation of the Federal Reserve in 1913 (Goodfriend and Hargraves, 1983).

RRs on foreign currency liabilities fulfill three desired features that are appropriate to deal with financial distortions. First, RRs signal financial intermediaries that foreign currency liabilities are riskier than their domestic currency counterparts; thus, RRs help banks to internalize dollarization risks. By setting higher RR rates on foreign currency liabilities, the BCRP increases the cost of providing foreign currency loans, and hence reduces the incentives of banks to intermediate in foreign currency, particularly in those credit market segments where borrowers have few alternative sources of funding.

Second, RRs reduce the likelihood of bank runs because economic agents realize that the banking system has a large pool of foreign currency-denominated liquid assets. RRs on foreign

currency deposits amount to about 20 percent of total international reserves, 50 percent of total foreign currency credit, and 44 percent of overall liabilities subject to RRs.

And third, RR policy contributes to increasing the amount of international liquidity in the financial system when necessary. This level of liquidity allows the central bank to act as LOLR in foreign currency by providing it whenever it is needed. By cutting RRs, a central bank can inject liquidity into the financial system and reduce pressures on the interest rate.

3.5 Credit Risk Induced by Currency Mismatch

The existence of currency mismatch in the balance sheet of domestic agents generates an externality to the financial system because agents either do not properly internalize the foreign currency-induced risk or engage in moral hazard behavior. Even non-tradable firms which set prices in foreign currency do not realize that the nature of the mismatch is real. In other words, a negative shock to the economy that depreciates the real exchange rate increases the real debt of the non-tradable firm (net present value of cash in dollars will fall).

There is also an externality that operates through the payment system. By taking dollar-denominated loans, an individual firm increases its default risk. However, it also increases the default risk of other firms, those that are linked to the first firm through the payment system. Banks do not properly internalize the complex degree of links between firms and consequently do not charge the proper risk premium when granting dollar-denominated loans to firms in the non-tradable sector. In this case, a sharp and unexpected depreciation of the exchange rate can trigger negative balance-sheet effects that spill over across the payment system to a large set of firms, unduly affecting the credit quality of bank assets.

It is worth mentioning that not only a sharp depreciation of the domestic currency generates systemic risk in a financially dollarized economy but also a strong and transitory appreciation of the domestic currency. A persistent and sharp appreciation of the domestic currency reduces the real value of firms’ debt, and it may also generate further appreciation expectations. As a result, firms may perceive that borrowing in foreign currency is cheaper, leading them to increase their currency mismatches and, through this channel, the cost of a sudden exchange rate reversal.

Therefore, policy actions such as additional provisioning for dollar-denominated loans, higher reserve requirements for foreign currency liabilities, and forex intervention to smooth exchange rate fluctuations contribute to dampening this type of credit risk.

3.6 RR as an Instrument to Increase Maturity and Temper Banks' External Leverage

Higher RRs to both foreign currency short-term external liabilities and foreign currency deposits not only increase the cost of dollar-denominated loans but also induce banks to lengthen the maturity of their external liabilities and to increase the availability of international liquidity.

In 2007, the BCRP extended the use of RRs to bank's short-term foreign liabilities.[13] As a result, banks had the incentive to lengthen the maturity of their foreign currency liabilities, which reduced their vulnerability to sudden stops of capital flows. Currently, a 50 percent special RR is in place for local banks' obligations to foreign banks with maturities of less than two years. Moreover, banks increased the average maturity of their foreign liabilities from two years in 2007 to four years in 2009. This special RR has also been used cyclically. The BCRP raises its level in periods of abundant capital inflows and reduces it in response to capital outflows.

Crucially, after the collapse of Lehman Brothers, the limited exposure of local banks to sudden stops of capital flows allowed banks to maintain their supply of credit, which limited the impact of this shock on the local financial system.

More recently, as a result of greater international financial integration and historically low levels of world interest rates, short-term capital flows[14] as well as firms' and banks' foreign liabilities, particularly bonds, have gained participation in the capital account. In order to limit over-borrowing, the BCRP set an additional RR to long-term foreign liabilities and bonds i) when the stock of these liabilities exceeds 2.2 times a bank's net worth and ii) when credit growth in foreign currency exceeds a particular limit established by the BCRP.

Furthermore, in 2013, with the aim of reinforcing credit de-dollarization, the BCRP set additional RRs for those financial institutions that grant foreign currency loans above some prudential limits.

[13] In 2004, the BCRP extended the use of RRs to banks' foreign liabilities.
[14] NDF forward operations with nonresident investors and purchases of public debt instruments denominated in domestic currency.

4. Measuring the Effects of Reserve Requirements

4.1 Analysis

In this section, we evaluate specific RR policy moves in terms of the direct outcomes outlined in Section 2 of the text. In particular, we aim to find the effect of RR policy applied to both domestic and foreign currency bank liabilities on interest rates and credit levels.

Econometric policy evaluation is a difficult task due to the identification problem. The usual tool in the monetary policy literature is to identify monetary policy through structural VARs. The VAR procedure is sound in a conventional monetary policy setting where the policy rate dynamically interacts with inflation, economic activity, and the exchange rate.

In the analysis of nonconventional monetary policy, it is important to account for episodes of policy interventions characterized by policy on-off situations. For those cases, Pesaran and Smith (2012) propose a policy evaluation exercise where the effectiveness of policy changes can be directly measured. The idea is to compare observed outcomes after a policy is changed against a counterfactual generated by an econometric forecast conditional on the policy not being implemented. Pesaran and Smith (2012) show that conditional forecasts can be generated by a reduced-form equation that links outcomes to both policy and controls invariant to policy.

All that is required to follow Pesaran and Smith's (2012) policy evaluation exercise is to define outcomes and instruments. The choice has to have the special feature that the instrument needs to be "off" for a time and then "on" for a reasonable amount of time. Three such episodes are identified: i) the increase in the marginal reserve requirement for domestic currency deposits from 6 to 25 percent since July 2010, ii) the increase in the marginal reserve requirement for foreign currency deposits from 30 percent to 55 percent since July 2010,[15] and iii) the increase in reserve requirements on banks' short-term external debt from 30 percent to 60 percent since July 2010. According to Pesaran and Smith (2012), what is needed is a reduced form equation of the form

$$y_t = \pi_1 x_t + \pi_2' W_t + \upsilon_{yt} \quad (1)$$

where y_t is an outcome variable, x_t is the policy instrument and W_t is a vector of control variables that are invariant to ad hoc policy changes. The set of outcome variables are given by

[15] There was a first tightening episode that started in February 2008 and spanned up to May 2008. However, this tightening was quickly reversed after the Lehman collapse, and thus it cannot be used in this exercise.

the levels of outstanding credit denominated in domestic and foreign currency, lending, and deposit interest rates denominated in both currencies and the ratio of short- to long-term bank external debt. Candidates for control variables include first a set of external variables like the Federal Funds rate, the VIX, the trade-weighted U.S. dollar index, the 10-year U.S. Treasury bond yield, and the slope of the U.S. yield curve. A second set of control variables comprises variables affected mostly by external conditions (terms of trade, the EMBI, domestic primary output) or by the financial development trend (number of employees, number of branches). The key assumption is that these sets of control variables are invariant to policy.

The outcome variables are depicted in Figures 10 to 13 (Appendix B). In the equations, credit levels are in logs (Figure 10) and bank lending and deposit rates have two forms. The interest rates can be calculated in terms of the outstanding stock of loans/deposits or can reflect the rates of new loans/deposits granted or received during the month. The latter shows a less persistent pattern than the rates applied to stocks, as depicted in Figure 11. The estimations made here are based on the interest rates on newly created loans and deposits at banks. Log credit levels at Cajas Municipales are shown in Figure 12, and they are specified by type. All Cajas credit is denominated in domestic currency. The corresponding interest rates at Cajas are described in Figure 13.

Each of these variables is modeled according to equation (1), and given that the outcomes and control variables follow unit root processes, the corresponding equations are estimated via dynamic OLS for cointegrating regressions.[16] Tables 2 and 3 in Appendix A show the best regression results for each outcome variable. Cointegration tests were run to validate the cointegration equations. In all cases, cointegration cannot be rejected using the Hasen parameter instability test, while the Engle-Granger and the Phillips-Ouliaris tests delivered mixed results. The sample period in all these regressions goes from 2003:01 up to 2012:12.

The next step in the methodology is to run forecasts conditional on the policy change not being applied (the counterfactual). The forecast runs from July 2010, which is the period the reserve requirement increases took place, and ends in December 2012. This means that in the case of the marginal reserve requirement for domestic currency deposits, the reserve rate is kept

[16] The unit root tests applied were the Augmented Dickey-Fuller, GLS-detrended Dickey-Fuller (Elliot-Rothenberg-Stock) and the Phillips-Perron. All the tests rejected the null hypothesis for the FTIPM variable so this is the only variable that is modeled in first-difference form. Results of the unit root tests are available upon request.

at 6 per cent whereas in the case of dollar deposits, the rate is kept at 30 percent. Also, the reserve requirement on banks' short-term external debt is kept at 30 percent.

The comparison of these counterfactual forecasts and the realized outcomes is made in Figures 15 and 16 on Appendix B. The solid lines are the realized outcomes, while the dotted lines are the counterfactuals. For example, in Figure 16, the counterfactual forecast outcome is mostly below the realized outcome. This means that the rise in RR affected loan interest rates in domestic currency upwards, as expected. But how far apart should counterfactual from realized outcomes be to have a better understanding of the statistical significance of the policy change?

To make an inference, a mean effect quantity is constructed through the use of the following equation:

$$\hat{d}_H = \hat{\pi}_1 \left[\frac{1}{H} \sum_{h=1}^{H} (x_{T+h} - x^0_{T+h}) \right] \quad (2)$$

where $\hat{\pi}_1$ is the estimated policy coefficient, H is the number of periods the specific level of policy tightening has been effective, x_{T+h} represent the observed policy trajectory from period T onwards and x^0_{T+h} is the counterfactual policy trajectory from period T onwards. The number of periods the policy stance lasted is H=22 months.[17]

Next, Pesaran and Smith (2012) propose a policy-effectiveness test statistic given by

$$\mathcal{P}_H = \frac{\hat{d}_H}{\hat{\sigma}_{v_y}} \sim^a N(0,1) \quad (3)$$

where $\hat{\sigma}_{v_y}$ is the standard error of the policy reduced-form regression. Namely, if the mean effect $\hat{d}_H$ is relatively large compared to the standard error of the forecasting equation, then it is likely that the policy effect is significant.

4.2 Results

The main empirical results of the paper are depicted in Table 1. The effect of reserve requirement changes that occurred in 2010 in general proved to have indeed increased lending interest rates and reduced deposit rates. The effect on bank interest rates implies that an increase in reserve requirements induce banks' interest rate spreads to widen, as described in Section 3 of

[17] On May 2012, the BCRP engaged in another round of reserve requirement measures.

this paper and consistent with general effects expected in the literature (for example Reinhart and Reinhart; 1999, Montoro and Moreno; 2011 and Terrier et al., 2011).

Table 1. Pesaran-Smith (2012) Policy Effectiveness Statistics

	Mean effect ($\hat{d}_H$)	Policy-effectiveness statistic ($\mathcal{P}_H$)	p-value	Expected sign
Bank lending rates in domestic currency	0.001	6.47	0.00	yes
d(Bank deposit rates in domestic currency)	-0.000	-0.02	0.49	yes
Bank lending rates in USD dollars	0.006	1.57	0.06	yes
Bank deposit rates in USD dollars	-0.009	-3.19	0.00	yes
Bank lending in Soles	-0.019	-0.57	0.28	yes
Bank lending in USD	-0.008	-0.49	0.31	yes
Bank's short-term external debt as a ratio of total external debt	-0.30	3.2	0,00	yes
Cajas interest rate to micro enterprises (short term)	0.028	2.85	0.00	yes
Cajas interest rate to micro enterprises (long term)	0.013	1.24	0.11	yes
Cajas Interest rate for consumer credit (short term)	-0.006	-0.41	0.34	no
Cajas Interest rate for consumer credit (long term)	0.037	5.14	0.00	yes
Cajas Interest rate for deposits (short term)	-0.002	-0.65	0.26	yes
Cajas Interest rate for deposits (long term)	0.011	2.98	0.00	no
Cajas consumer credit	0.009	0.97	0.17	no
Cajas credit to small firms	-0.009	-0.30	0.38	yes
Cajas mortgage credit	-0.442	-12.28	0.00	yes

Furthermore, there is evidence that the effect on credit works as expected, though it is statistically less significant. These results on the effects on credit levels are also compatible with the findings of Dancourt (2012). This last paper performs panel regressions with credit levels at banks and Cajas. In addition to standard control variables, Dancourt (2012) introduces the interest rate policy and reserve requirements to study the importance of these instruments.

The last empirical result presented here relates to the increase in required reserves for banks' short-term external debt. The evidence provided here is that this policy action produced a shift in banks' external debt toward long-term maturities and away from short-term debt.

In the case of reserve requirements for soles-denominated deposits, the policy instrument is the marginal reserve requirement. However, for U.S. dollar-denominated deposits, an augmented reserve requirement ratio has to be constructed in order to account for the fact that banks can more easily substitute this source of funding via external liabilities or with bond issues. Hence, an augmented effective reserve ratio is constructed by dividing the amount of U.S. dollar reserves by the sum of augmented U.S. dollar liabilities. Augmented U.S. dollar liabilities include dollar deposits, external debt, and bond issues. The bottom panel in Figure 14 shows the

evolution of this augmented ratio. Even though the standard reserve requirement measure started to increase in July 2010, this augmented ratio did not change by much in the period under analysis, showing the fact that banks were active in managing their liability portfolio. Nevertheless, the impact of the policy as regards to U.S. dollar interest rates and dollar denominated credit are as expected.

5. Conclusions

Nonconventional policy tools, such as reserve requirements, are being used actively by many central banks in emerging market economies. The evidence provided by the Peruvian experience shows that this policy instrument is an effective tool to reduce the tradeoffs that expansionary monetary policies in developed economies are creating in emerging market financial systems. In particular, reserve requirements can dampen credit cycles in periods of capital inflows and reduce their expansionary effects on domestic aggregate demand. Additionally, when reserve requirements are applied to foreign currency bank liabilities, they can contribute to increasing the availability of international liquidity in the financial system and consequently help to reduce the impact of capital outflows on the domestic financial system.

The paper performs counterfactual exercises following Pesaran and Smith (2012) to quantify the effect of a marginal reserve requirement tightening that spanned the period 2010:07 to 2012:04. The effects are measured in interest rates and credit levels.

As with any other form of tax, RRs generate efficiency costs, which can affect the degree of financial system development. However, when financial frictions pervade, these costs are of second-order magnitude compared to the benefits of an active use of RRs that reduces the probability of financial crisis. In that sense, the calibration of RR needs to take into account these costs to define both the magnitude and the duration of these types of nonconventional policy instruments.

In economies like Peru's, where domestic capital markets are not well developed, RRs can also speed up the development of these markets by increasing the cost of financial intermediation through the banking system. However, they could also increase the incentives for firms to use more external funding.

The aforementioned costs can be reduced by spreading the burden of prudential regulation among a larger set of instruments, such as cyclical capital requirements and dynamic

provisioning and, in the case of financially dollarized economies, additional capital requirements for loans in dollars. The central bank has to continuously assess the efficacy of RRs as prudential instruments and reverse them when necessary. For instance, RRs on short-term bank liabilities were reduced in 2012 for those liabilities oriented to finance trade operations to avoid the substitution of banking credit by off-shore credit lines.

The Peruvian experience also shows that central banks need to monitor closely the impact of these types of instruments in order to minimize its potential costs. Close coordination with the regulatory authority is also necessary to complement reserve requirements with the use of other instruments aimed at reducing systemic risk, such as counter-cyclical provisioning and capital requirements, and higher capital requirements for foreign loans.

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Appendix A. Tables

Table 2. Regression of Outcome Variables against Policy and Control Variables (Banks)

	FTAMN	D(FTIPM)	FTAMEX	FTIPMEX	Log(Bank Lending Soles)	Log(Bank Lending USD)	Short-term to total bank's external debt
d(Marginal reserve requirement in Soles)	0.101 [2.556]*						
Marginal reserve requirement in Soles		-0.004 [0.476]			-0.111 [-1.074]		
Augmented reserve requirement in USD			0.390 [3.028]**	-0.635 [-8.705]**		-0.536 [-0.353]	-0.74 [-3.17]**
FTAMN(-1)	0.887 [19.615]**						
D_LTWDINDEX	0.093 [2.036]*	0.011 [1.283]					
D_FFED	-1.846 [-3.327]**						
VIX	-0.021 [-1.910]	-0.003 [-1.521]					
Log(Trade weighted dollar index)							
Fed fund rate			0.915 [10.018]**			2.900 [3.090]**	
10 year Peruvian TB yield							0.09 [3.36]**
EMBI			0.576 [2.024]*	0.754 [5.287]**		19.965 [13.291]**	-0.14 [-7.29]**
Log terms of trade			-0.062 [-2.540]*	0.082 [13.201]**			
Log of number of braches at banks				-0.193 [-11.332]**	1.573 [13.455]**		
Constant	0.029 [2.754]**	0.001 [1.486]	0.163 [1.591]	1.044 [9.470]**	12.203 [16.420]**	21.843 [37.740]**	0.49 [2.10]*
D(FTIPM) (-1)		0.675 [10.046]**					
@TREND			0.002 [6.737]**	0.001 [7.264]**	0.008 [7.333]**	0.010 [2.309]*	
@TREND^2			-0.000 [-5.552]**			0.000 [1.107]	

Table 3. Regression of Outcome Variables against Policy and Control Variables (Cajas Municipales)

	Interest rate to micro enterprises (short term)	Interest rate to micro enterprises (long term)	Interest rate for consumer credit (short term)	Interest rate for consumer credit (short term)	Interest rate for deposits (short term)	Interest rate for deposits (long term)	Consumer credit	Credit to small firms	Mortgage credit
Marginal reserve requirement in Soles	0.162	0.075	-0.032	0.216	-0.013	0.065		-0.050	-2.578
	[2.180]*	[1.751]	[-0.567]	[11.510]**	[-1.625]	[2.257]**		[-0.698]	[-7.313]**
Reserve requirement in Soles							-0.043		
							[-0.286]		
Log(Trade weighted dollar index)	0.190		0.668	0.205			-0.561		-5.030
	[5.511]**		[8.871]**	[3.727]**			[-8.412]**		[-16.792]**
Fed fund rate	1.120		2.842	-0.445			4.095		-14.197
	[5.016]**		[4.542]**	[-3.741]**			[8.356]**		[-8.946]**
Log of number of braches at Cajas	0.320	0.543	0.665		0.021	0.088		-1.148	-2.410
	[5.583]**	[13.620]**	[6.138]**		[5.992]**	[5.459]**		[-9.647]**	[-11.709]**
Log of number of employees at Cajas	-0.588	-1.015	-0.506	-0.102				3.042	
	[-5.039]**	[-11.122]**	[-6.192]**	[-11.801]**				[10.218]**	
Log terms of trade							-0.260		
							[-3.243]**		
Constant	2.606	5.571	-2.126	0.265	0.064	-0.233	16.276	-3.712	44.640
	[3.691]**	[11.063]**	[-4.425]**	[0.832]	[3.970]**	[-2.994]**	[42.184]**	[-2.230]*	[23.975]**
@TREND	0.004	0.007			-0.002	-0.002	0.014	-0.013	0.046
	[2.855]**	[6.688]**			[-21.278]**	[-12.061]**	[29.939]**	[-3.934]**	[16.183]**

Appendix B. Figures

Figure 10. Levels of Bank Credit

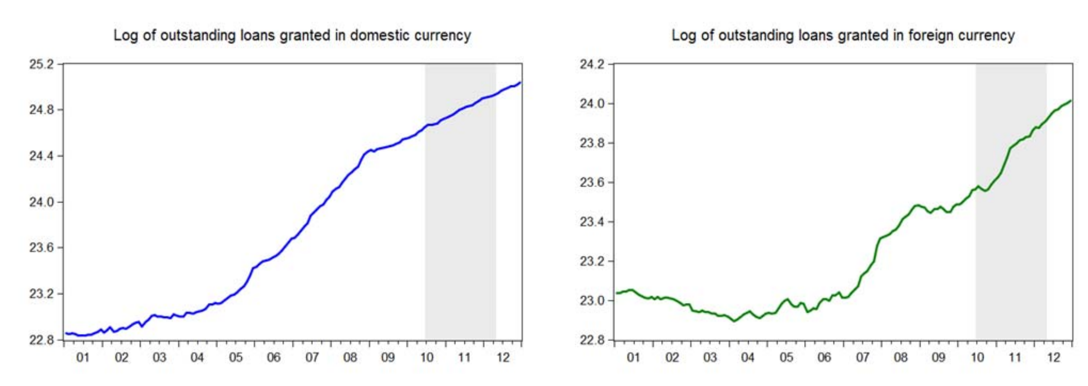


Figure 11. Interest Rates in the Banking System

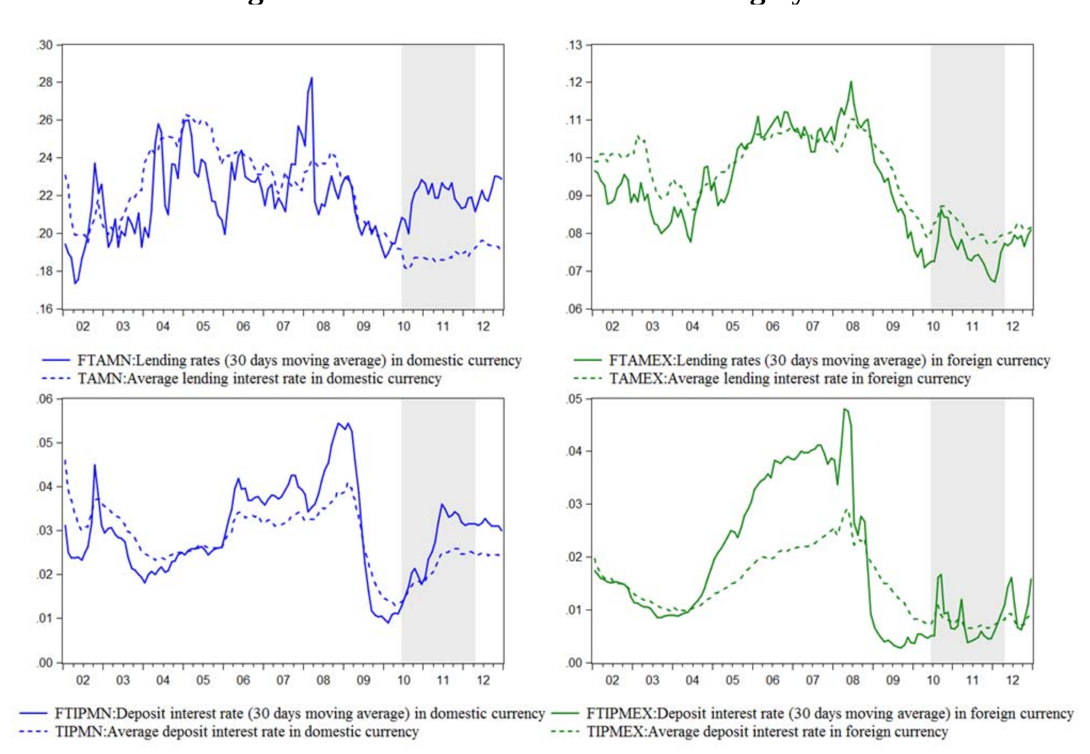


Figure 12. Levels of Credit at Cajas (domestic currency only)

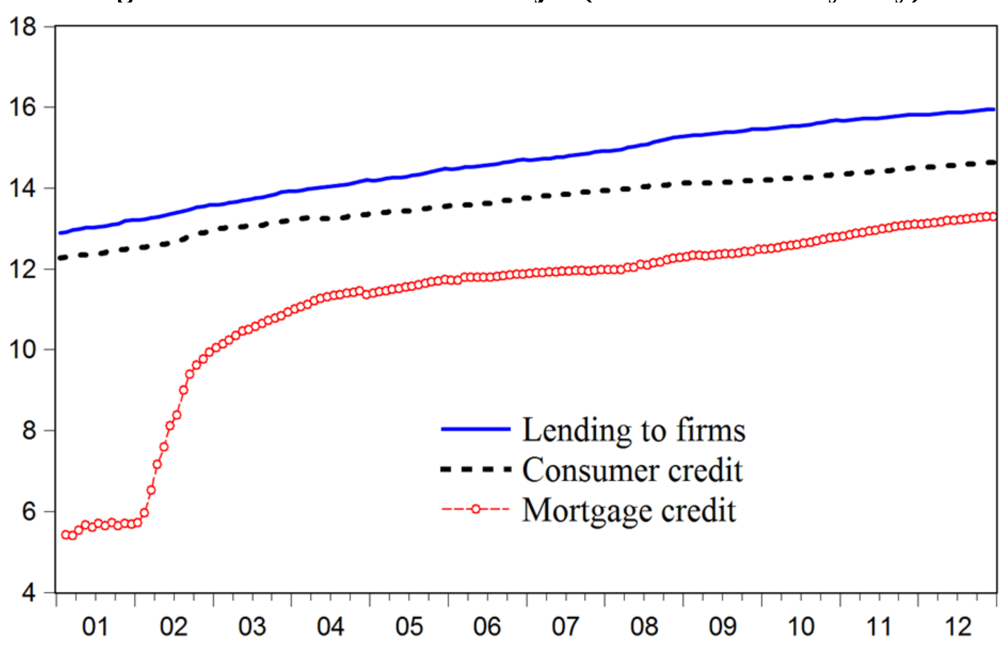


Figure 13. Interest Rates Set by Cajas

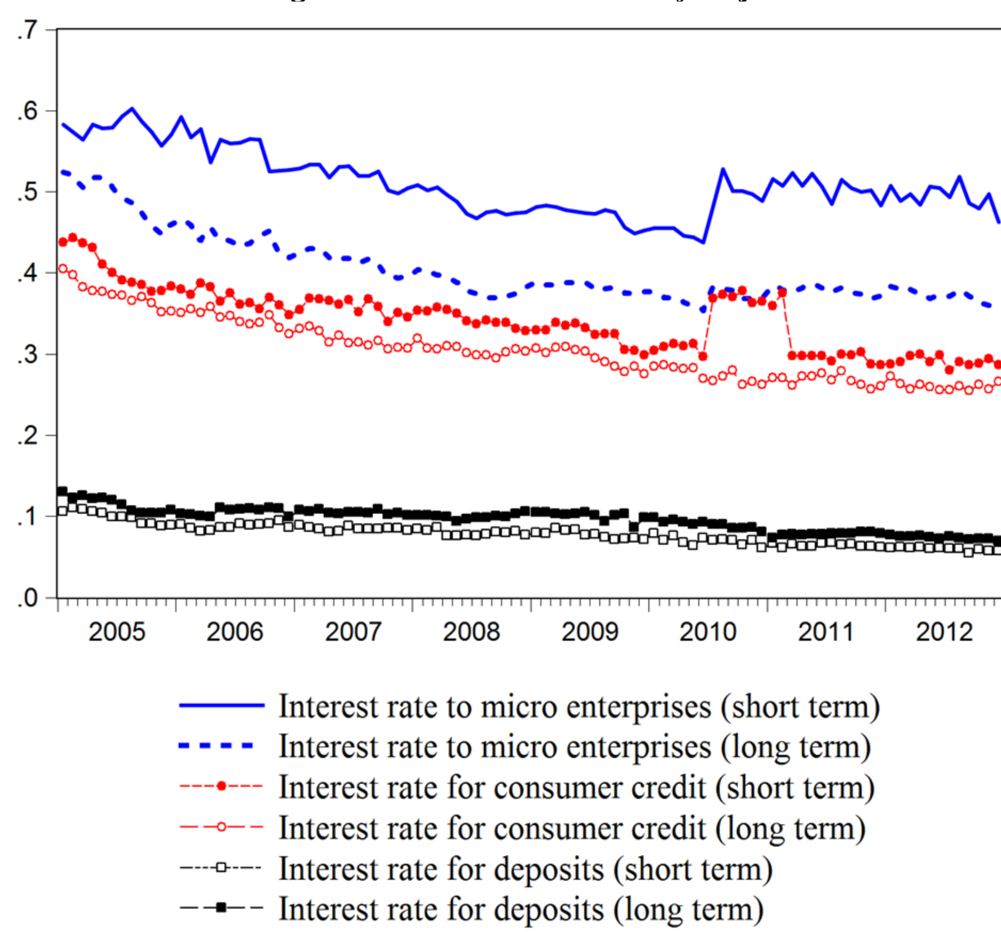
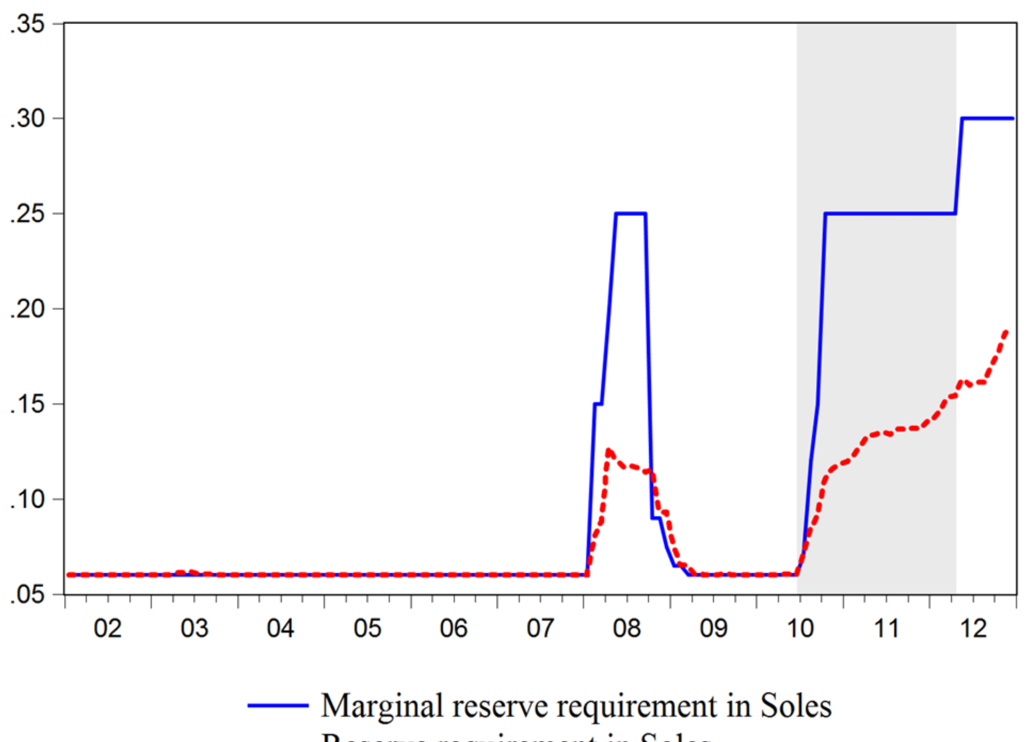


Figure 14. Path of Policy Variables



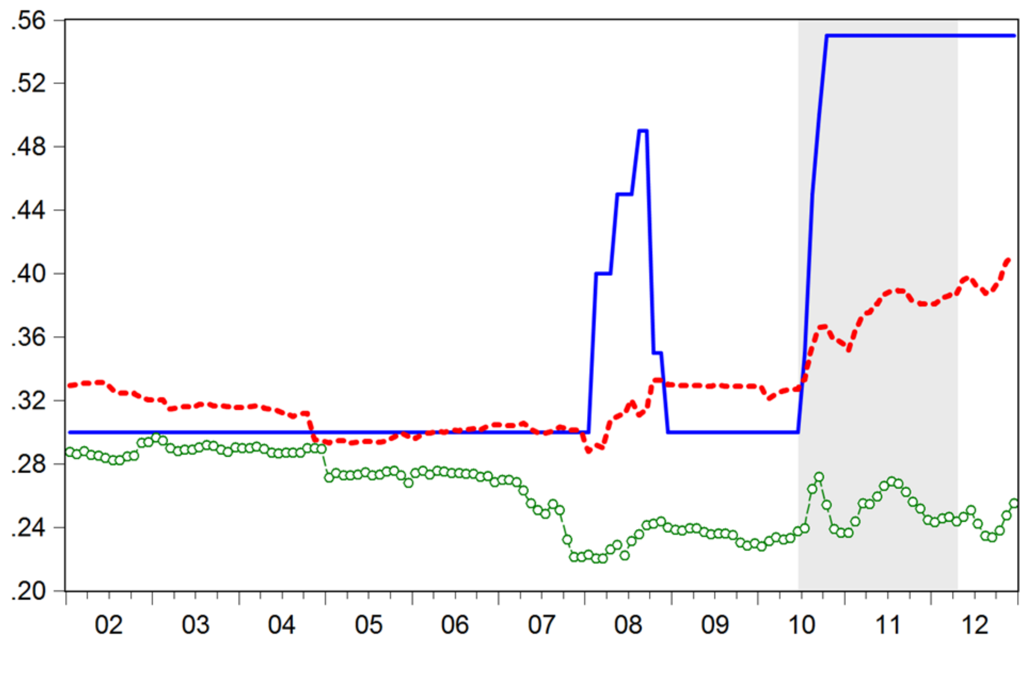


Figure 15. Path of Observed and Counterfactual Outcomes at Banks

FTAMN:Lending rates (30 days moving average) in domestic currency
FTAMN:Lending rates (30 days moving average) in domestic currency (Baseline)

D_FTIPM
D_FTIPM (Baseline)

FTAMEX:Lending rates (30 days moving average) in foreign currency
FTAMEX:Lending rates (30 days moving average) in foreign currency (Baseline)

FTIPMEX:Deposit interest rate (30 days moving average) in foreign currency
FTIPMEX:Deposit interest rate (30 days moving average) in foreign currency (Baseline)

Log of outstanding loans granted in domestic currency
Log of outstanding loans granted in domestic currency (Baseline)

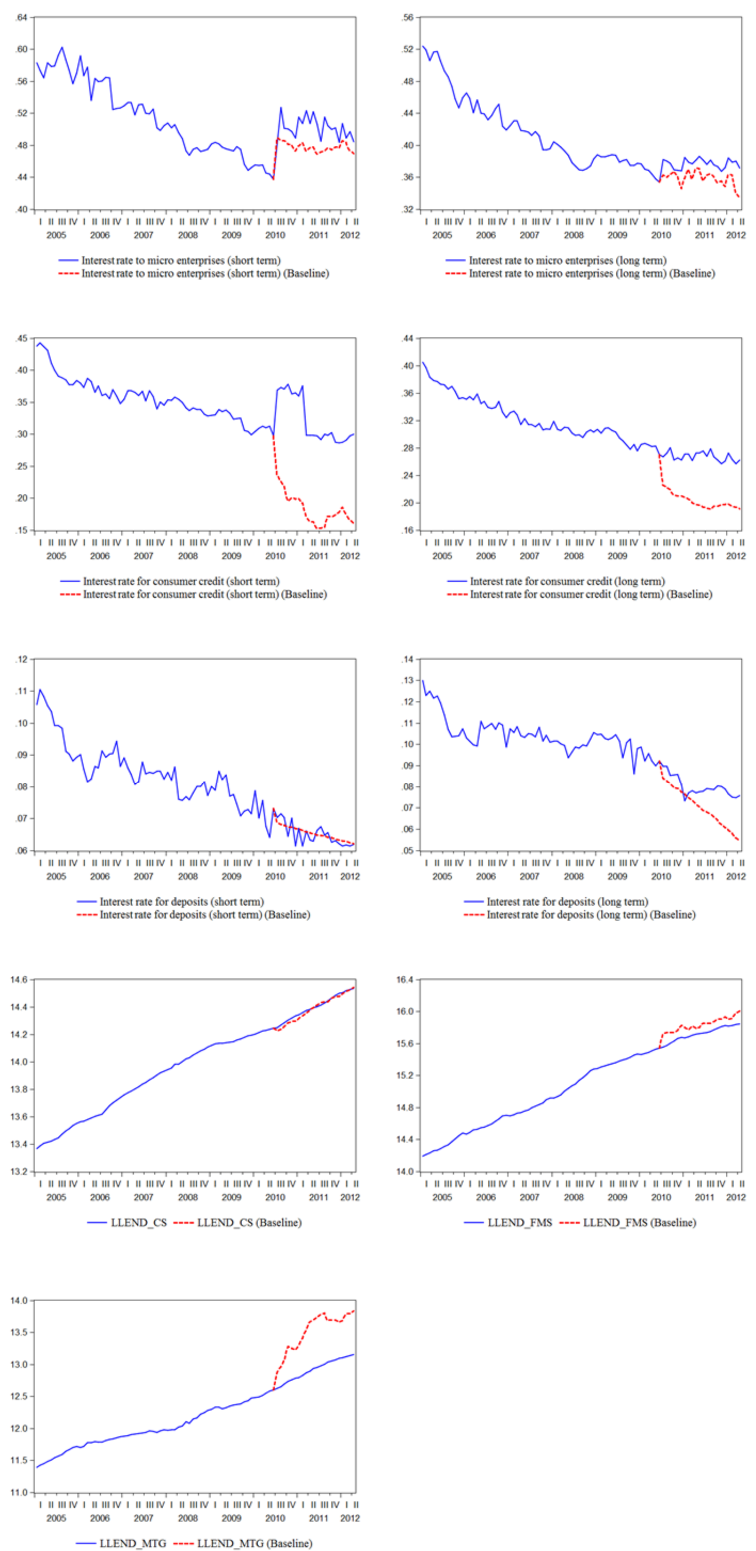
Log of outstanding loans granted in foreign currency
Log of outstanding loans granted in foreign currency (Baseline)

Bank's short term external debt as proportion of total external debt
Bank's short term external debt as proportion of total external debt (counterfactual)

Note: The solid lines are the counterfactuals (no policy tightening).



Figure 16. Path of Observed and Counterfactual Outcomes at Cajas



Note: The solid lines are the counterfactuals (no policy tightening).